Determining Shape Evolution of Electrothermally Launched Flyers in Impact Welding with Multi-point PDV

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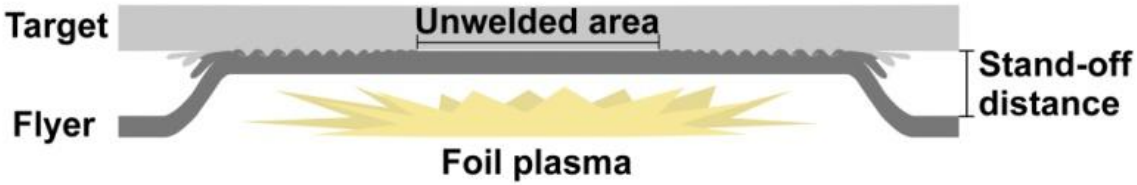
DEPARTMENT OF
MATERIALS SCIENCE
AND ENGINEERING

Motivation

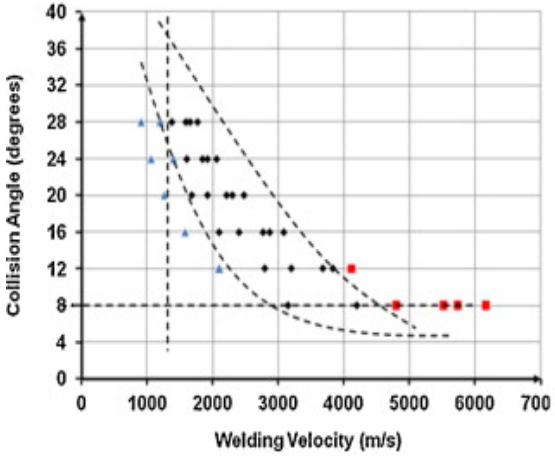


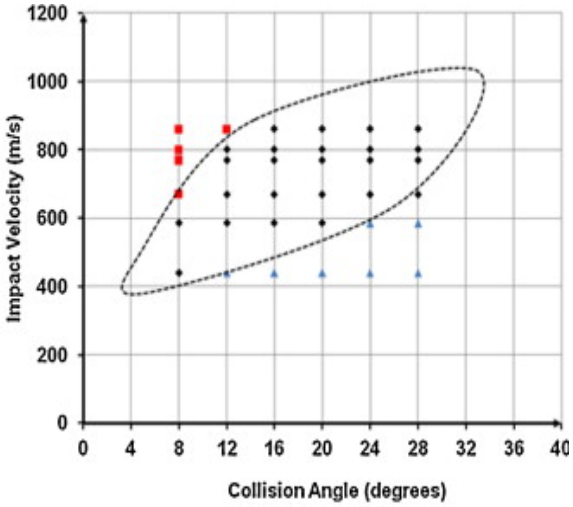
- Impact Welding
  - Contributing factors for joint efficiency
    - Velocity, collision angle, material thickness
    - Vaporizing Foil Actuator Welding (VFAW) was used to establish welding window of velocity and angle
  - Interface morphology
    - Intermetallic compounds
    - Waviness

Sponsored by National Science Foundation

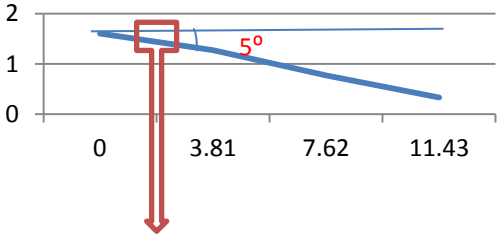
Motivation

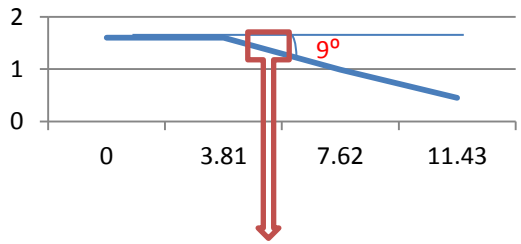
Welding Window for Cu-Ti
(Vivek et al. 2014. JMPT)

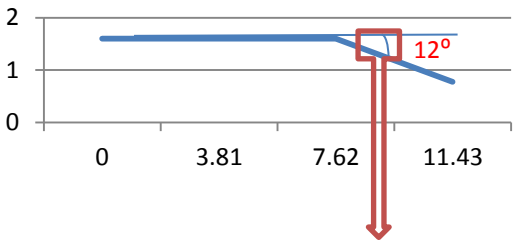




- Angle Effect on Weld Interface at 560 m/s

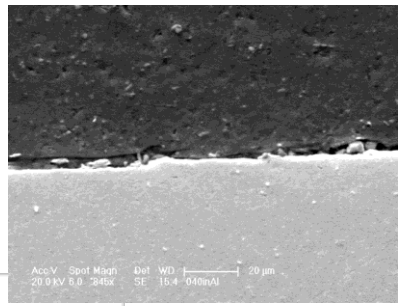


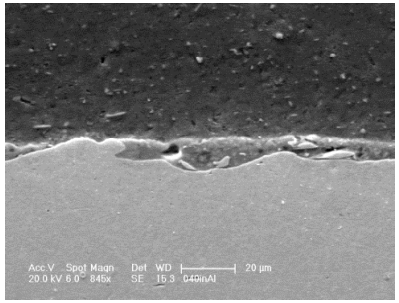


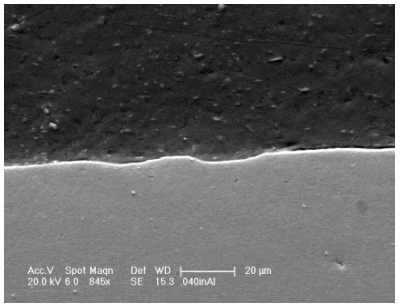


AA 1100

1018 Steel







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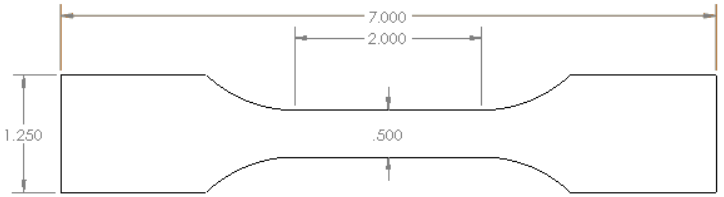
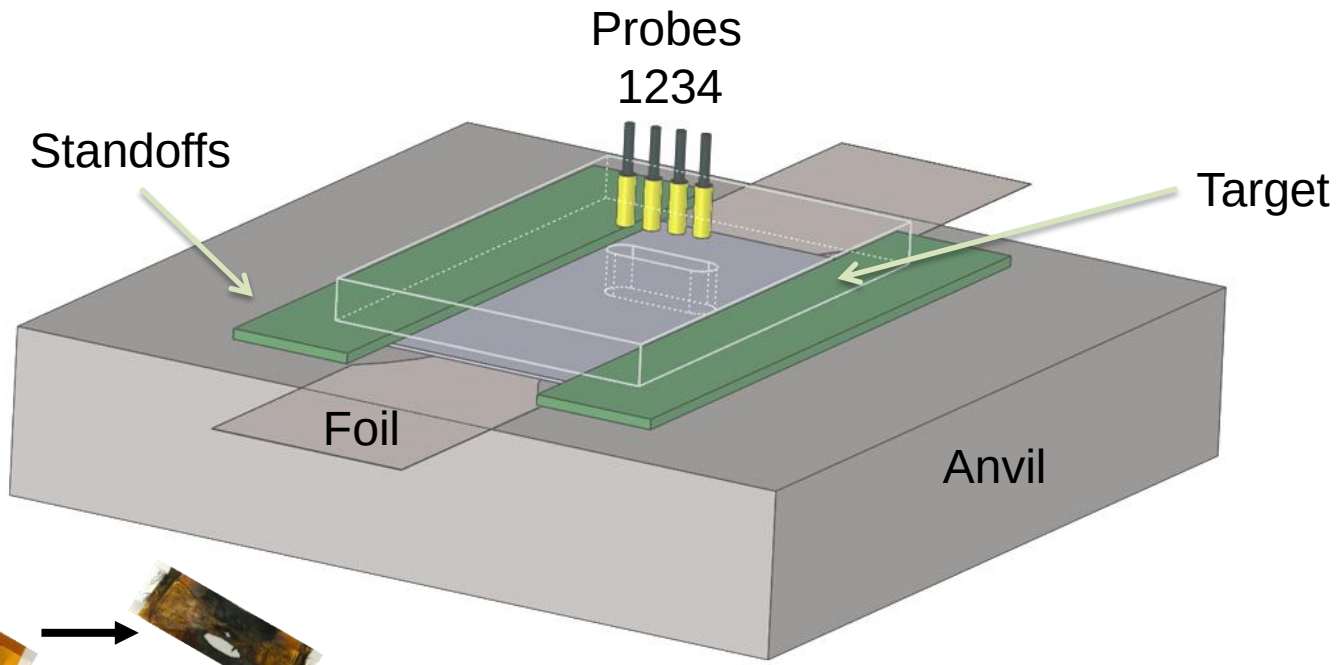
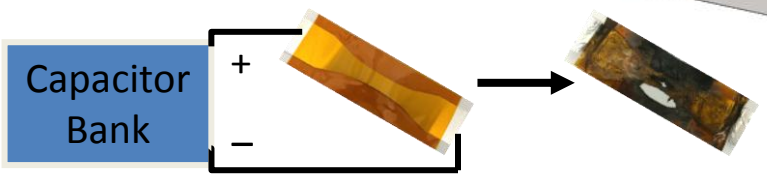
Method One – Normal linear array

- Experimental Setup

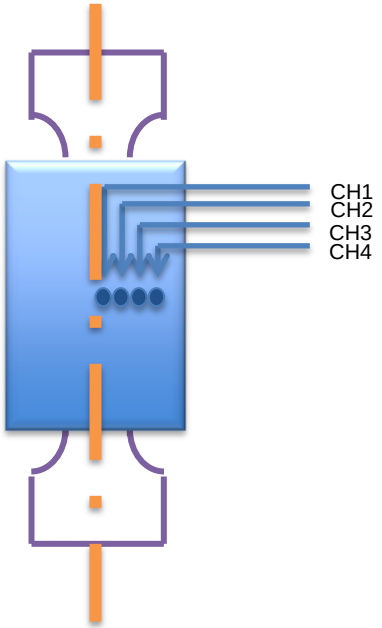


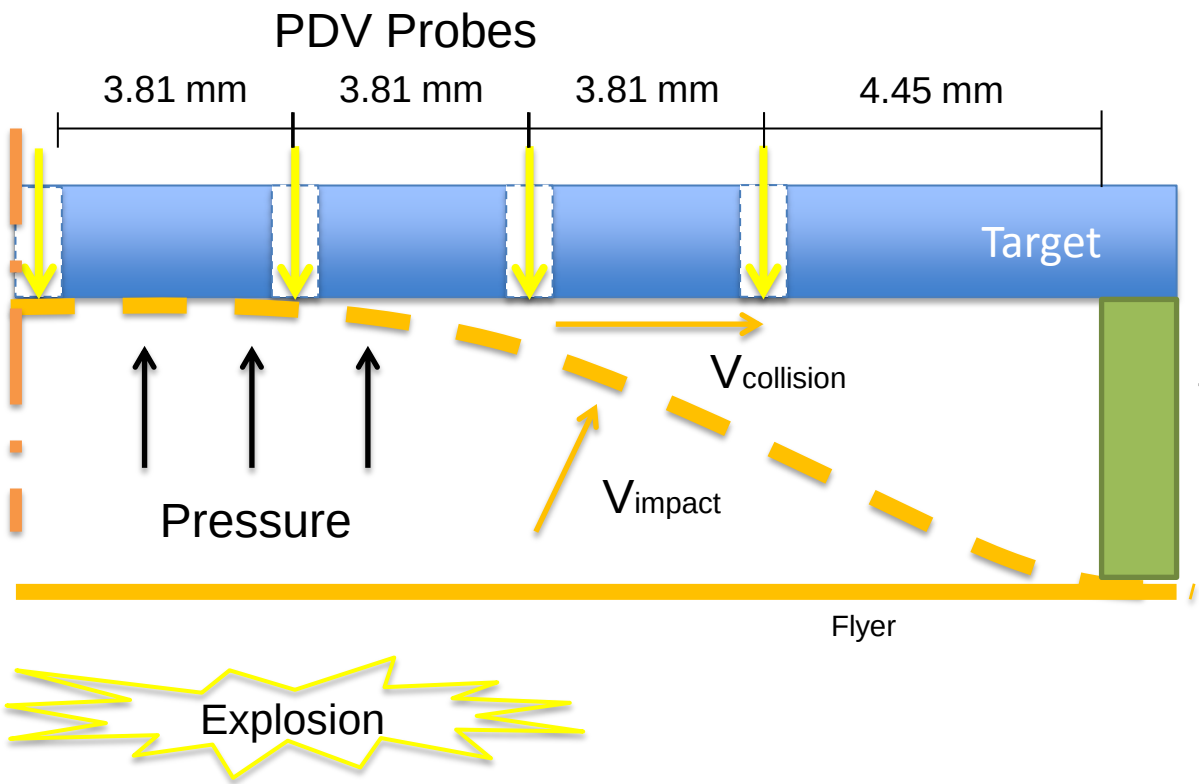




Method One

- Schematic



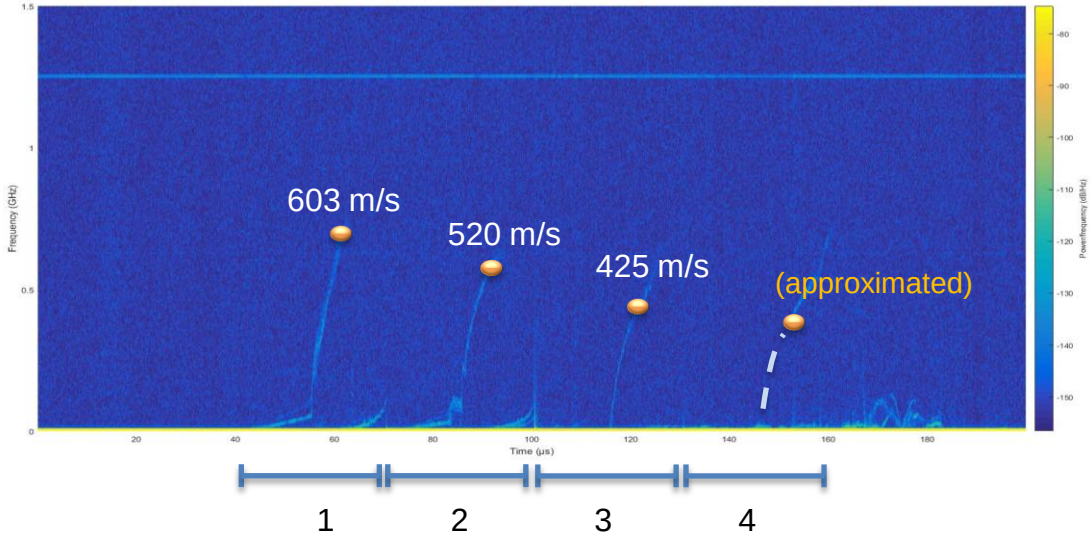


Traveling distance (1.6 mm) in this study

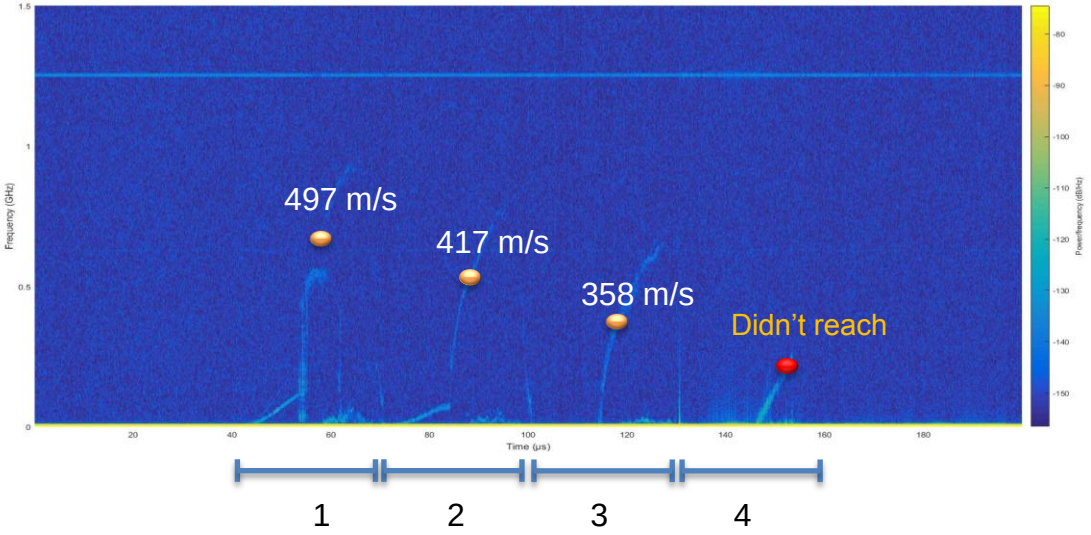
Results

- = standoff distance

.001 inch thick AA1100 at 2.5kJ



.010 inch thick AA1100 at 3.5kJ



Probes separated by 30 µs delay

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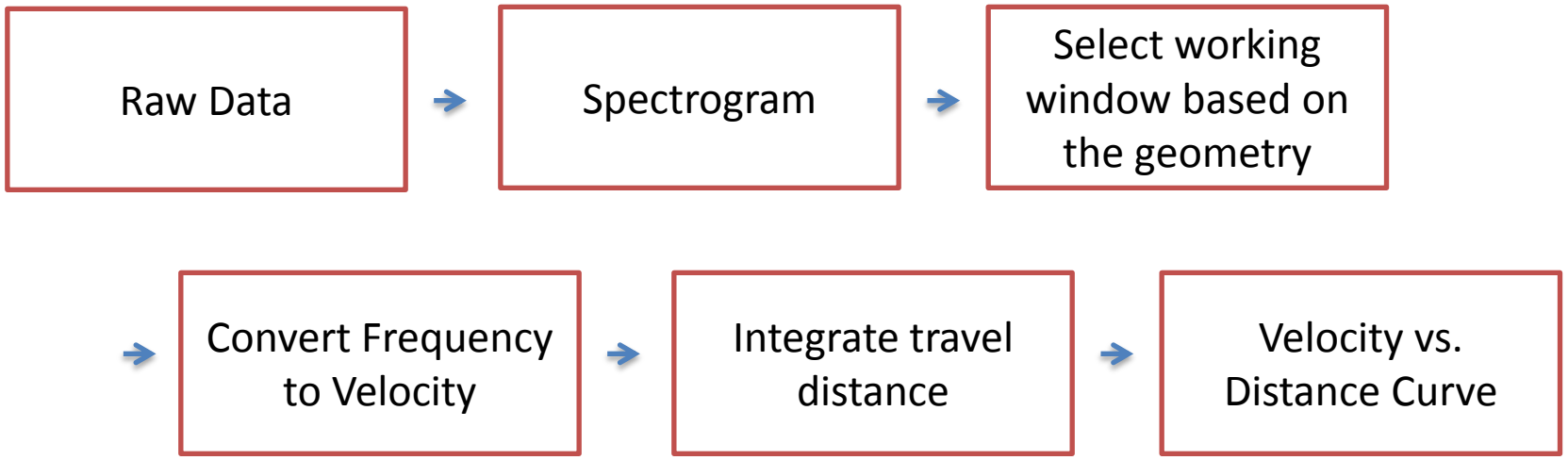
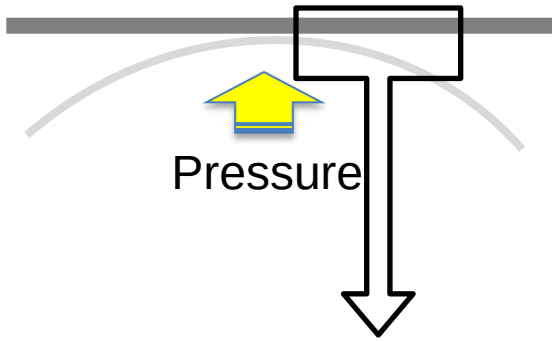
Results

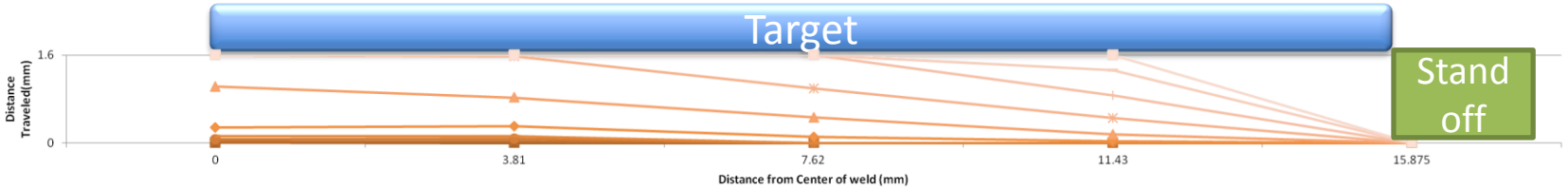
- Flow Chart for Data Acquisition



Results

- Flyer Evolution





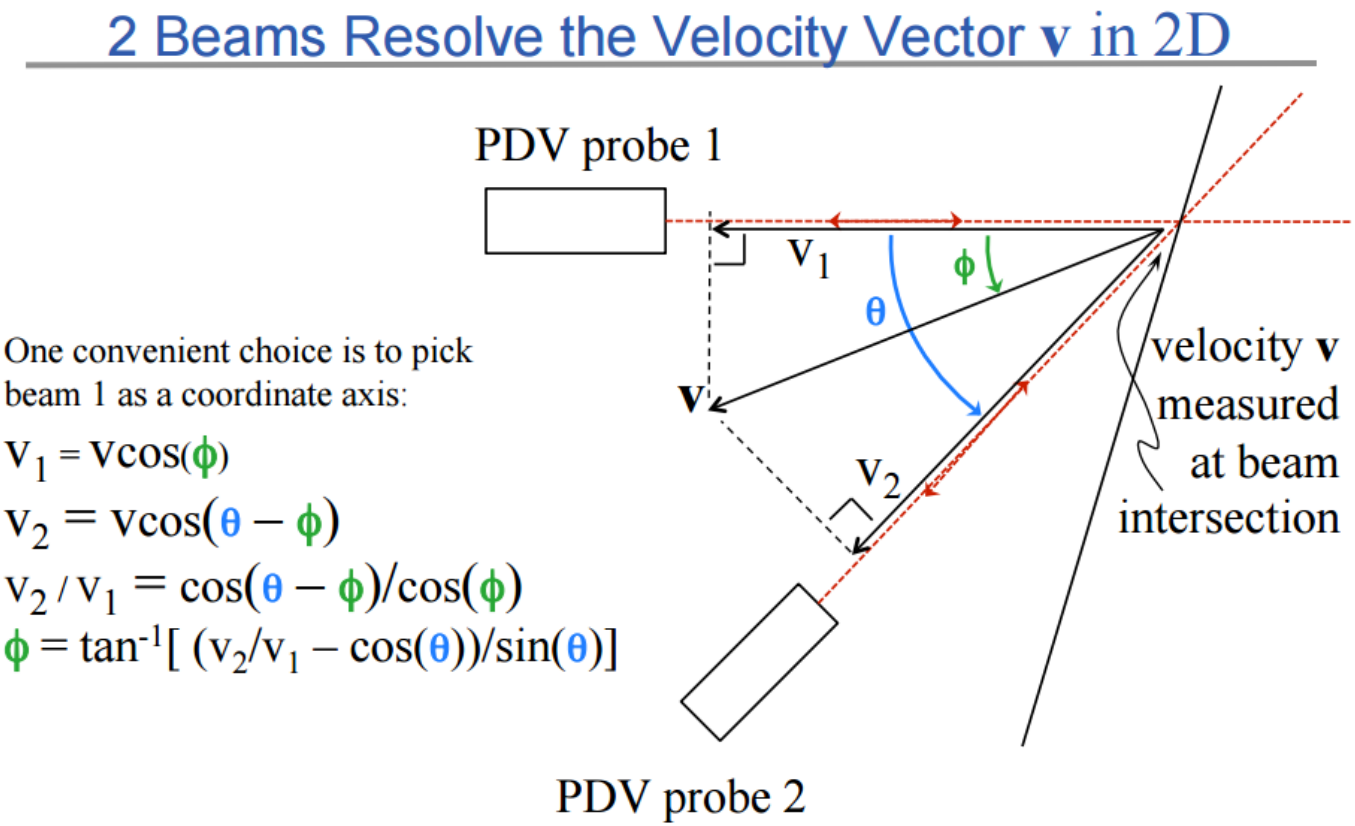
AA 1100 .040 in thick at 5kJ
Center velocity at collision: 560m/s

Click *Slide Show* for video

Limitation

- Requires very good reflectivity from flyer
  - Retrotape (sometimes spalls off)
  - Marker
  - Brushed surface
- Limited to rough estimation of angle
  - Shorter distance between probes?

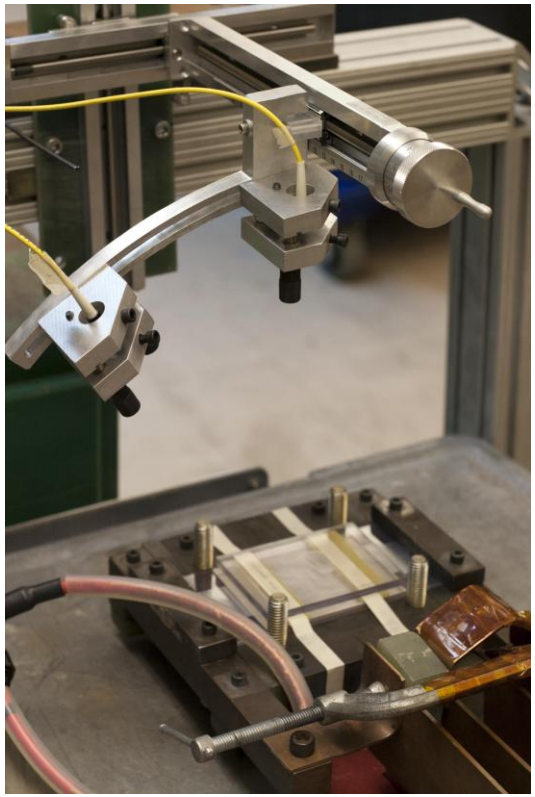
Method Two

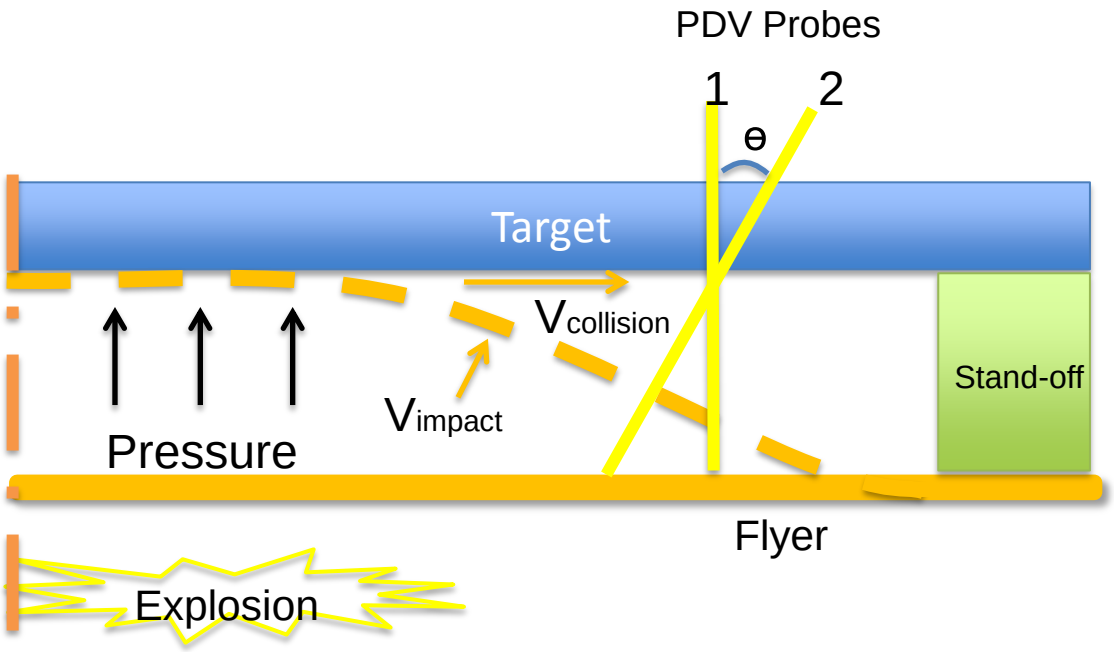


Courtesy: Briggs et al. (2010) PDV Workshop

Method Two

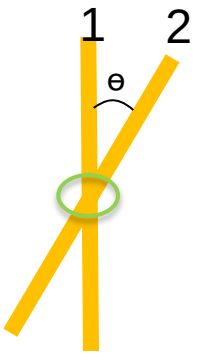
- Tilted Probing



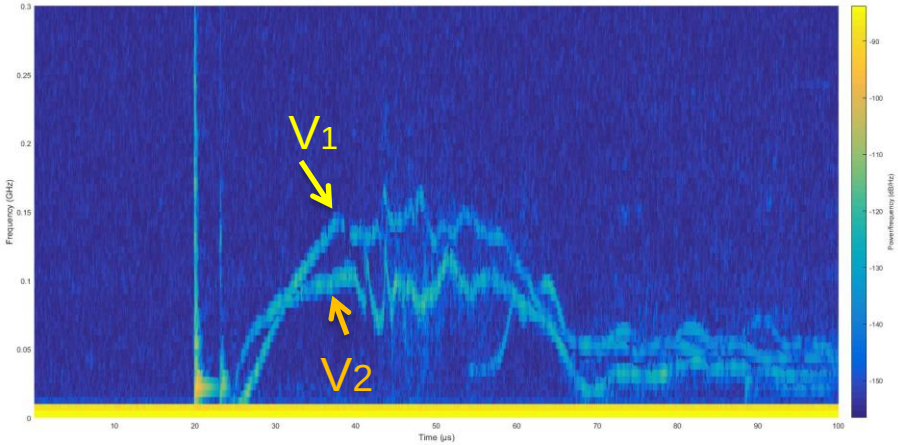


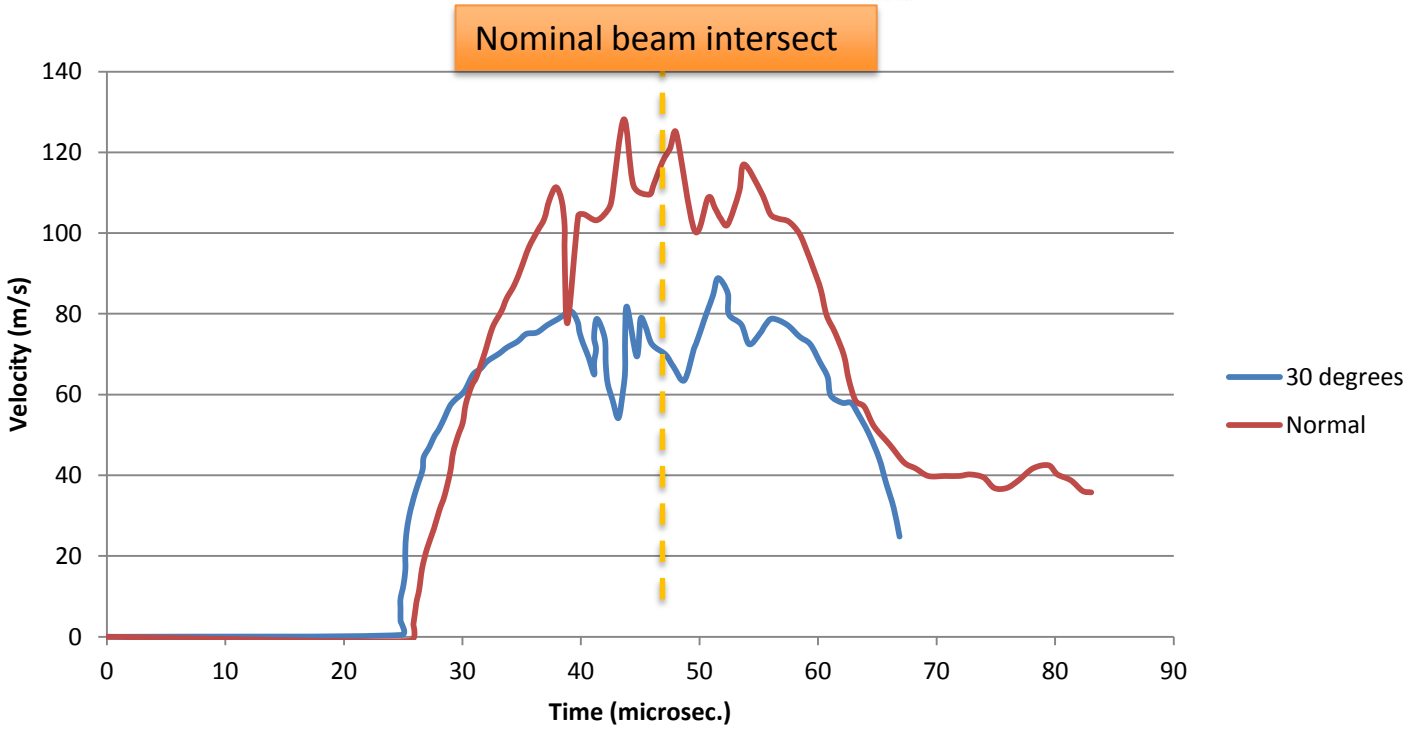
Results

PDV Probes



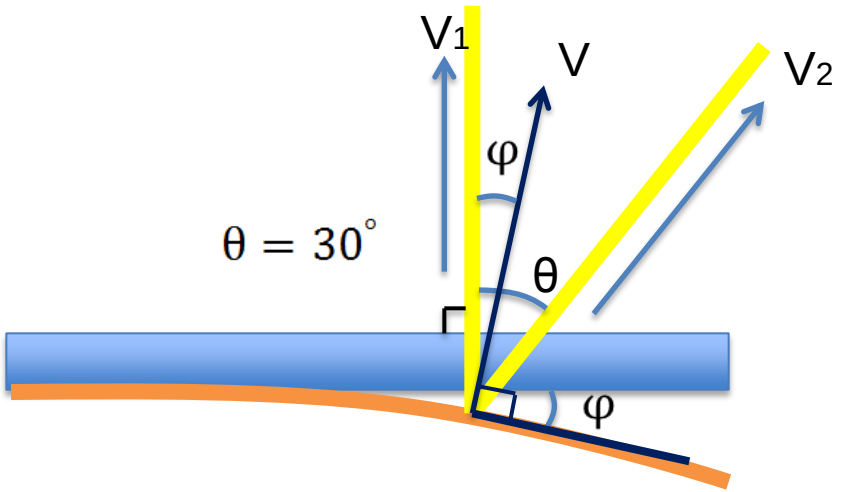
Spectrogram





Results

- Tilted Probing Example



$$\varphi = \tan^{-1}\left[\left(\frac{V_2}{V_1} - \cos\theta\right) / \sin\theta\right]$$

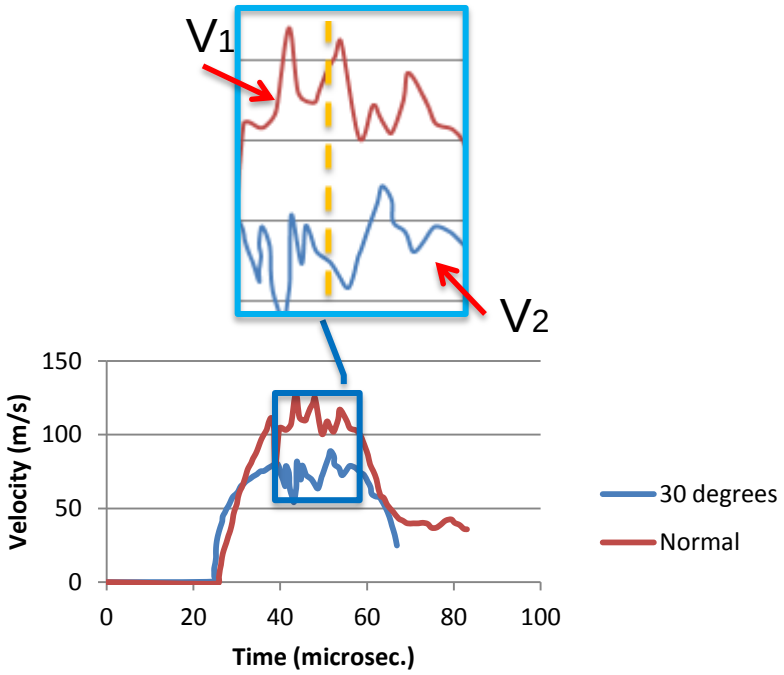
$$V = V_1 / \cos\varphi$$

At 1.8 mm,

$V_1 = 121$ m/s $V_2 = 77$ m/s

$\varphi = 25^0$

$V = 134$ m/s



Conclusions

- High Fidelity Signal is required for both methods
- Normal probe array shows unique flyer evolution for different thicknesses
- Two or more arrays of tilted probing will give us more precise angle at multiple locations

Thank you

Questions?

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